Anne Vikkula – Sirkka-Liisa Seppälä – Terttu Lempiäinen

THE ANCIENT FIELD OF RAPOLA

Abstract

In 1988 and 1989 a prehistoric field with ard marks was excavated on the southwestern slope of the Rapola hillfort, located in Valkeakoski (Sääksmäki) in Central Häme (Tavastia), South Finland. The field is dated to 780–1217 cal AD (2σ), and is estimated to be between 500 and 600 m² in area. Beneath the modern plough layer was a partly disturbed ancient plough layer in which the prehistoric ard marks formed a dark criss-cross pattern in the sandy soil. Large numbers of macrofossils were identified, including Cerealia such as *Avena sativa, Hordeum vulgare, Secale cereale,* and *Triticum cf. aestivum*. Remains of an older dwelling site were also identified. The site dates back to the Pre-Roman period and the beginning of the Iron Age. The remains and features included burnt clay, fireplaces and two grains of *Triticum compactum.*

Anne Vikkula, University of Helsinki, Department of Archaeology, P.O. Box 13, FIN-00014 University of Helsinki, Finland

Sirkka-Liisa Seppälä, National Board of Antiquities, Department of Archaeology, P.O. Box 913, FIN-00101 Helsinki, Finland.

Terttu Lempiäinen, University of Turku, Department of Biology, FIN-20500 Turku, Finland.

THE RAPOLA HILLFORT RESEARCH PROJECT

The Rapola hillfort is situated in Valkeakoski (Sääksmäki, Central Häme [Tavastia, Sw. Tavastland], Fig. 1). It was already known in the seventeenth century, when it was drawn on a map as "a castle which was planned to be built on the hill and where walls can still be seen". At the close of the nineteenth century the archaeologist Hjalmar Appelgren-Kivalo (1891, 22–24) tried to date the fort, which at the time was the primary goal of archaeological research. Excavations were carried out in the early years of the twentieth century. A.M. Tallgren investigated burial cairns on the southwest slope of the hill, mainly trying to date them. A few years later (1918, 1920) Julius Ailio adopted a somewhat different approach: taking great care not to damage the area, he attempted to clarify the nature of the structures of the fort itself, drawing up a reconstruction of the walls (Ailio 1921). Sakari Pälsi carried out a few inspections in later connections, but the structures at the top of the hill were the subject of less attention (Pälsi 1921; see Taavitsainen 1990, 158–160, 228–229).

The numerous burial cairns and mounds at Rapola were investigated by Eino Rinne in 1930 (Jutikkala 1934) and by Esko Sarasmo in 1945. In 1949 Jouko Voioinmaa carried out excavations in the fort area at the top of the hill and in 1950 he excavated several cairns and mounds in the Matomäki and Hirvikallio cemeteries on the slopes at Rapola. The recovered stray finds and excavated materials were used to demonstrate connections between Rapola and Central Europe, the East Baltic regions and areas as distant as the Oka and Kama rivers in Russia (Voionmaa 1953). The assumed level-ground cemetery of Rupakallio was excavated by Pirkko-Liisa Lehtosalo in 1960–1962; the results concerned comparisons of artifacts and chronological conclusions (Sarvas 1976, 88–89; Lehtosalo-Hilander 1990; cf. Taavitsainen 1992, 12).

In the 1980s, plans to build a motorway through

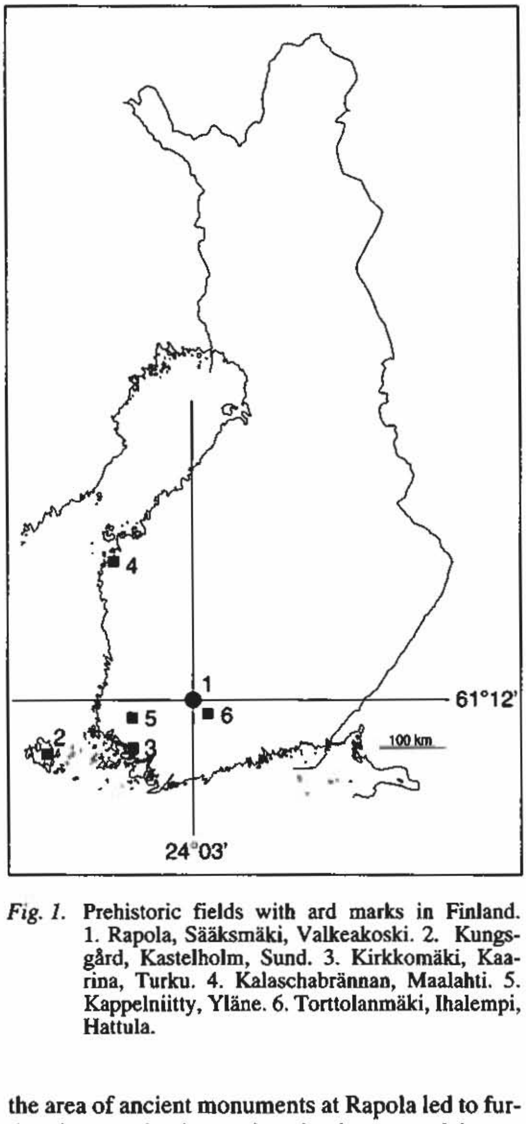

Fig. 1. Prehistoric fields with ard marks in Finland. 1. Rapola, Sääksmäki, Valkeakoski. 2. Kungsgård, Kastelholm, Sund. 3. Kirkkomäki, Kaarina, Turku. 4. Kalaschabrännan, Maalahti. 5. Kappelniitty, Yläne. 6. Torttolanmäki, Ihalempi, Hattula.

the area of ancient monuments at Rapola led to further interest in the ancient landscape and its remains (Hirviluoto 1987). A project was planned to test previous assumptions that there are traces and remains of prehistoric occupation in the hillfort area. The aim was to locate dwelling sites and, where possible, to obtain information on buildings, the ancient village structure, and the relationship between the fort and the surrounding settlement. The project was financed by the Academy of Finland, Neste OY, the Ilmarinen Insurance Company, and the municipality of Valkeakoski.

Field work was carried out between 1987 and 1990. A new archaeological survey of the old parish of Sääksmäki was accomplished. In addition to radar and magnetometric surveys, soil-phosphate studies and small-sample prospecting analyses were conducted on the southwest slope of the hill to locate possible dwelling sites. Excavations were partly in trial trenches and sections and partly in larger areas. These were intended to provide information on assumed areas of other ancient activities than burials alone. Small areas were also excavated within the walls at the top of the hill to obtain a more detailed picture of the actual use of the fort. The results of the prospecting led to the excavation of the ancient field, which was estimated to be of main importance.

In this article, the archaeological description and conclusions are by Seppälä, the archaeobotanical results are presented by Lempiäinen, and the overview of the project and the interpretation of ^{14}C dates are by Vikkula, who was also the director of the project.

TOPOGRAPHY

The ancient field at Rapola is on the incline of a glaciofluvial esker sloping southwest towards the shore of Lake Vanajavesi, the main water route of the Häme region (Fig. 2). The top of the slope, at 149 metres above present sea level, is almost 70 metres above the surface of the lake (79.4 metres a.s.l.). The southwest slopes of the actual esker formation are steep, containing large stones and rocks as a result of the Yoldia Sea and Ancylus Lake phases of the Baltic. Except for the hillfort at the crest of the ridge, remains of human occupation and settlement are below 100 metres a.s.l., the location of the steepest incline. The terrain slopes more gently in this part, but owing to postglacial processes, particularly shore action in the late stages of the Ancylus Lake and Lake Vanajavesi, the landscape is varied and consists of small details. Processes of wear and conglomeration have produced shore formations on both sides of the ridge, running parallel to the 85–95-metre contour lines. These are up to a few hundred metres wide and several metres high and mainly consist of even-grained sand and fine sand. Lowermost on the slope nearest the shore, clay dominates in the soil, covered in many places by fine sand or fine silt. (Map of the quaternary deposits, 1:20 000, 2132 02 SÄÄKSMÄKI).

The ridge and the surrounding shore formations, the nearby outcrops of bedrock and moraine areas to the southeast and the clays and peaty soils along the shore all constitute a varied environment with a favourable micro-climate which was already utilized effectively by Iron Age settlers. Accordingly, the ancient field discussed in this article was originally cleared on a sunny southwest slope on an area of level ground located above an Ancylus Lake shore formation. This site was an excellent

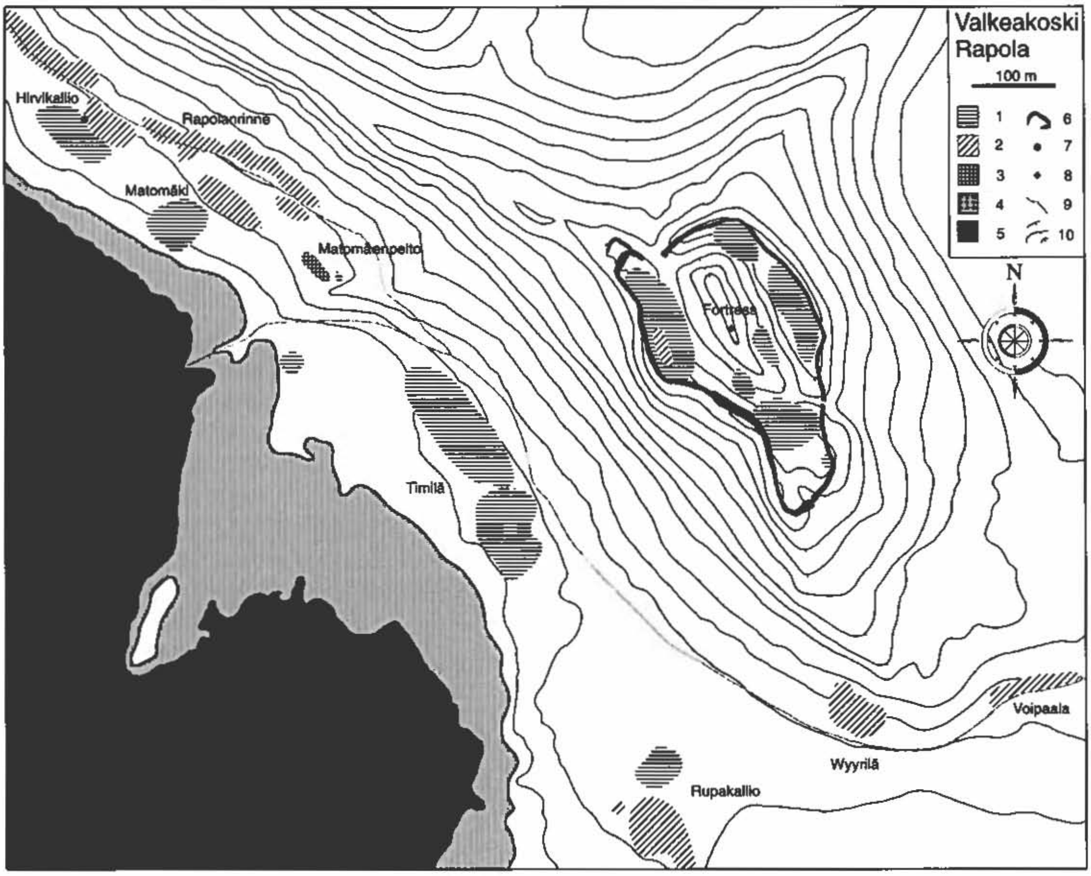

Fig. 2. Map of the Rapola hill fort area and different types of ancient remains. 1. Dwelling sites 2. Cemeteries 3. Ancient field 4. Water at the end of the Iron Age 5. Water today 6. Fort contructions 7. Hollowed stone 8. Well 9. Path 10. Contours.

choice both geomorphologically and in view of climatic conditions (Fig. 3).

DOCUMENTATION

The location selected for excavation was a site that appeared to be topographically suited to habitation with respect to the above-mentioned factors. A number of Iron Age remains are known from the immediate vicinity. Field work was begun with the trial excavation of a trench 120 metres long and 4 metres wide on the southwest slope. The trial trench provided a section of the whole topographical layout of the location.

Fig. 3. Overview to the landscape of the ancient field. Photo: S.Rintala/National Board of Antiquities.

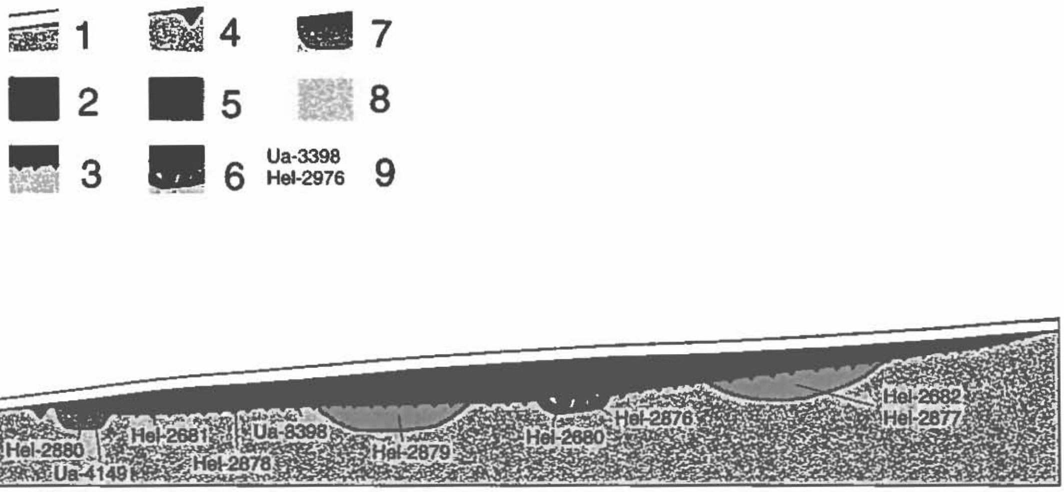

Fig. 4. Projected section of stratigraphy. 1. Recent plough layer 2. Ancient plough layer; sandy humus with some soot and charcoal 3. Ard marks; dark sandy humus with soot and charcoal 4. Possible ditch at the edge of the ancient plough layer 5. Plot of dirty or sooty soil; sand 6. Fireplace I; stones and a large amount of soot and charcoal 7. Concentration of burnt clay; clay daub, stones and charcoal 8. Subsoil; fine and coarse sand and gravel 9. Radiocarbon sample by laboratory number.

The excavated area was in an existing field. According to cartographic material, this field had already been under cultivation in the seventeenth century (Map of lots and fields 1641, MHA BB1A 23). Consequently, the surface layer had become completely mixed over the centuries. Excavation was begun by removing mechanically the layer formed by modern and recent cultivation. The subsequent soil layers were first dug in five-centimetre levels and later by following the stratigraphy of the ancient field. All finds were recovered and recorded to the nearest square centimetre. Finds from historically documented times were also recovered systematically, as they could help to outline the history of cultivation and land use at the site until the present. The stratigraphy and all related features and structures were documented with drawings and photographs. Samples for radiocarbon dates, macrofossil analyses and soil studies were taken systematically from various parts of the stratigraphy and from individual features.

STRATIGRAPHY

The uppermost layer consisted of the modern and recent plough layer, which had an average thickness of 20 cm. In the upper parts of the slope this layer overlay the gravelly soil of the ridge and in the lower parts it covered Ancylus clays predating the isolation of Lake Vanajavesi and inundation layers resulting from the later transgressive stage of the lake. In the middle of the slope between these soil areas was an ancient shore formation roughly 20 metres wide and at least one metre thick, which consisted of sand and fine sand. Beneath the present plough layer several indications of anomalies caused by human action were observed. These dated from prehistoric times to the present.

In the ancient shore deposit, excavation revealed a dark lenticular layer (c. 18 x 28 metres) beneath the present plough layer. The dark layer was at its thickest (40–50 cm) in the middle of the area, being only a few centimetres thick at the edges. In section, the bottom of the layer was clearly basin-shaped. The relatively homogeneous soil consisted of mixed mull and sand. Traces of present-day tillage could be observed in places in the upper part of the dark layer. There was no stratigraphy within the layer, but its lower edge contained a great amount of soot and small particles of charcoal. In horizontal view, the light-brown sand beneath the dark layer revealed dark, narrow streaks at intervals of a few dozen centimetres. At the bottom of the dark layer, or stratigraphically beneath it, a few features and patches of discoloured and sooty soil could be observed in the mineral soil. In addition to the dark layer, the present-day plough layer also revealed a number of anomalies in other parts of the excavated area. There were also ditches and pits beneath the present-day plough layer that had been used in historically documented times and subsequently filled (Figs. 4, 5).

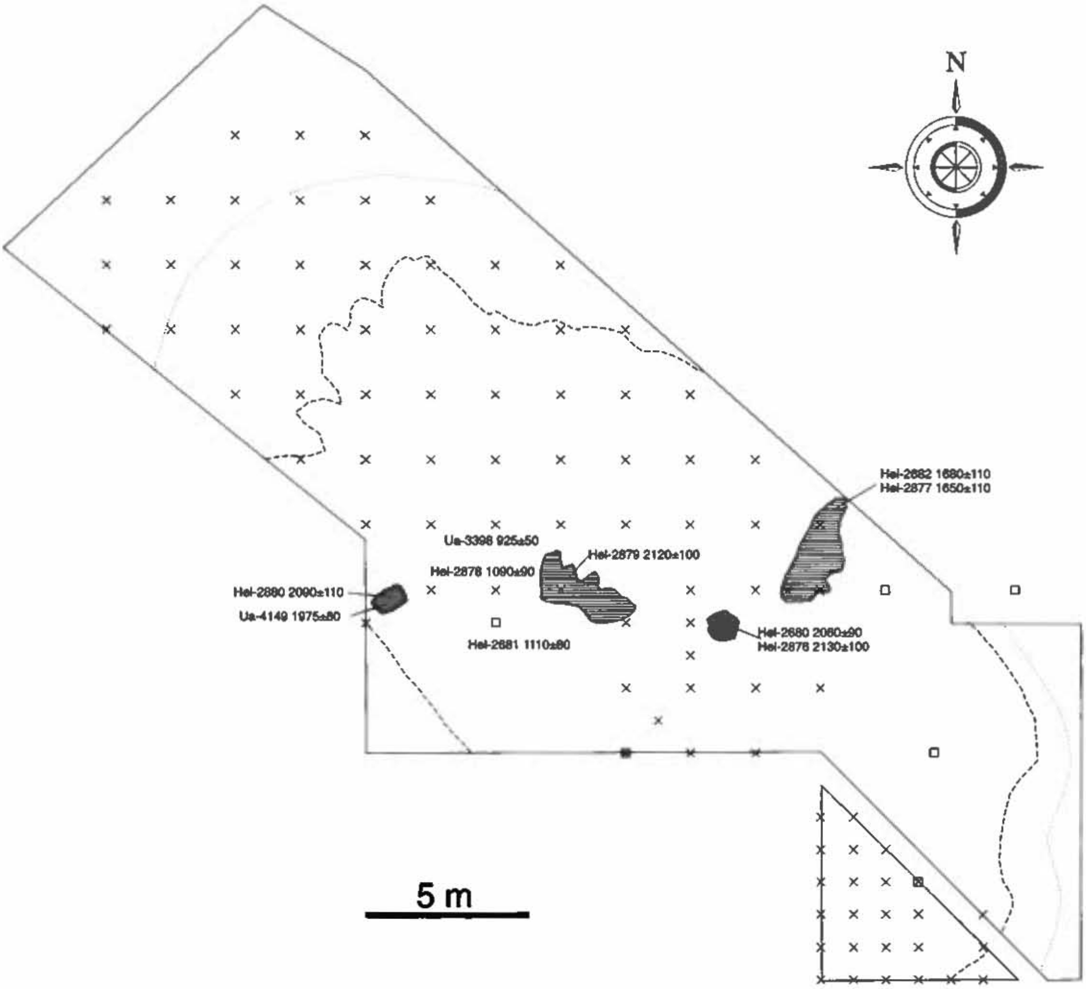

Fig. 5. Map of the excavation area, sampling sites and structures. Dotted line – outer limit of the field. Broken line – outer limits of the ard marks. Hatched – concentration of burnt clay. Shaded – pit of dirty soil. Black – fireplace I. Square – macrofossil sampling site, pillar. Cross – macrofossil sampling site, single.

ARD MARKS

The streaks were first observed horizontally as narrow lines at the edges of the dark layer, where it was thinnest (only a couple of centimetres thick). The streaks mainly followed the forms of the terrain (i.e. SW-NE), and they clearly appeared to be linked closely to the dark layer and its process of formation. In view of these observations, the dark layer was interpreted to be an ancient plough layer, and the streaks as furrows produced by what was most probably an ard.

The whole layer was then carefully excavated down to the surface of the mineral soil, and, as expected, ard marks were observed in a large area. The total area of ard marks corresponded to that of the layer interpreted as the ancient plough layer, i.e. a minimum of 500–600 m^2. To the northwest and north, the marks ended at a gravel formation a few metres wide and 10–15 cm thick. Overlaying the gravel was an approximately one-metre-wide feature of dense mull and pits containing mull and sand. To the southeast and south, the marks ended at the boundary of coarse gravel and stones. Among the stony gravel was a discoloured edge feature that was hardened by the clay and darkened by the mull. Downhill to the southwest the boundary of is indistinct, but excavation in section revealed a furrow 30 cm wide and 15 cm deep that may have been a small ditch. In all parts

Fig. 6. Plan of the ancient field with ard marks and other features.

of the perimeter some of the marks appear to have been destroyed by later working of the soil (Figs. 6, 7).

The ard marks were 2–10 cm wide, averaging 6 cm. They varied in length from a few dozen centimetres to 2–3 metres. As a rule, the marks ran abreast and consecutively in parallel lines, but none of them extended in uniform configuration for any greater length. They mostly met at an angle of 80–90 degrees, formed a fairly uniform and distinct criss-cross pattern, which was only disturbed by later tillage. Present-day cultivation had partly obscured the ard-mark level at the edges of the area, which were close to the bottom of the modern plough layer. No groups of marks running solely parallel to each other were observed. Not all the marks are distinct streaks; many ended or converged in irregularly shaped dark patches of soil. Furrow depth was approximately 5 cm from the bottom of the dark layer, which was the documentation level used. In section, the furrows are of relatively symmetrical V or U shape. The bottom part of some of the furrows had two depressions. In the best-preserved areas, a sample of ard-mark sections indicated an average distance of 18 centimetres between them.

It was observed at the documentation level that the mark or the furrow made by the tip of the ard had a maximum width averaging 6 cm and a depth of 5 cm. Accordingly, the size and shape of the original furrow could be estimated. Fig. 8 presents a schematic suggestion of the average dimensions of the ancient furrow and the resulting thickness of the plough layer. The other furrow shown in the illustration contains a picture (to correct scale) of the only prehistoric ard share hitherto found on the Finnish mainland (NM 10896: 76; Kivikoski 1973, 127, Abb. 988, Tf. 109).

Fig. 7. Overview of the ancient plough layer with ard marks during the excavation, from the east.

OTHER STRUCTURES

At the documentation level of the ard marks, or beneath it, a number of distinct features were discovered (Fig. 5). In comparison with the ancient plough layer these constituted a separate group in terms of stratigraphy, function and dating. The most prominent feature is a small fireplace of stones arranged in a simple construction (Fireplace I). Its relationship with the ancient plough layer is open to various explanations. There were no distinct ard marks in its immediate vicinity, and consequently no reliable stratigraphic conclusions can be drawn. There were no ard marks beneath the fireplace, which cannot be considered younger than the ard marks even according to the radiocarbon date (see below). The ard was most probably lifted over the stone setting of the fireplace during the ploughing, or any marks crossing the hearth never extended down to the mineral soil.

At a lower point on the slope a concentration of burnt clay was discovered which had been partly damaged by the ard marks. This feature was approximately one metre long and 40 cm wide, ex-

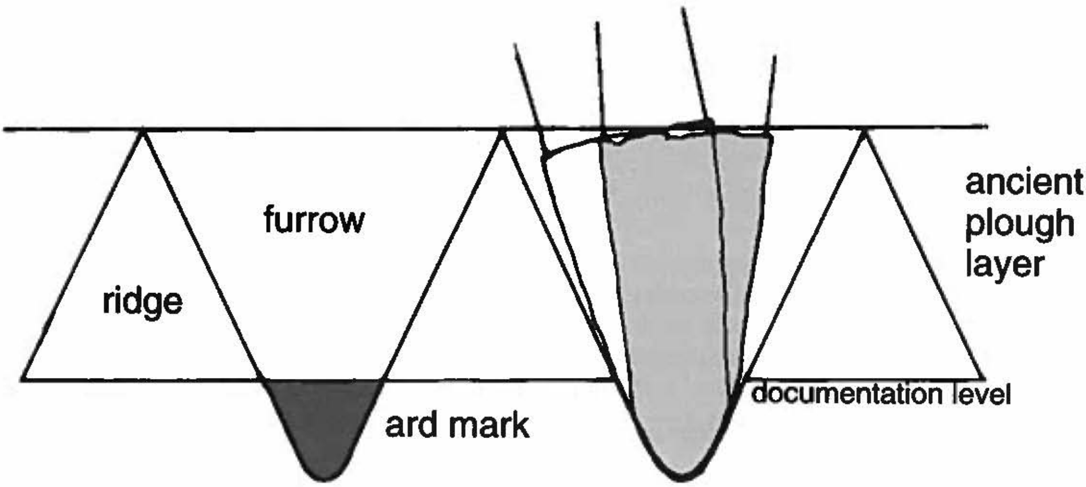

Fig. 8. Suggested structure of the ridges and furrows based on the documented level and sections of the ard marks. On the right, an iron ard share (NM 10896:76), found in a Viking Age cemetery 35 km southeast from Rapola, placed into the furrow. The angle of the tilted position is about 10°.

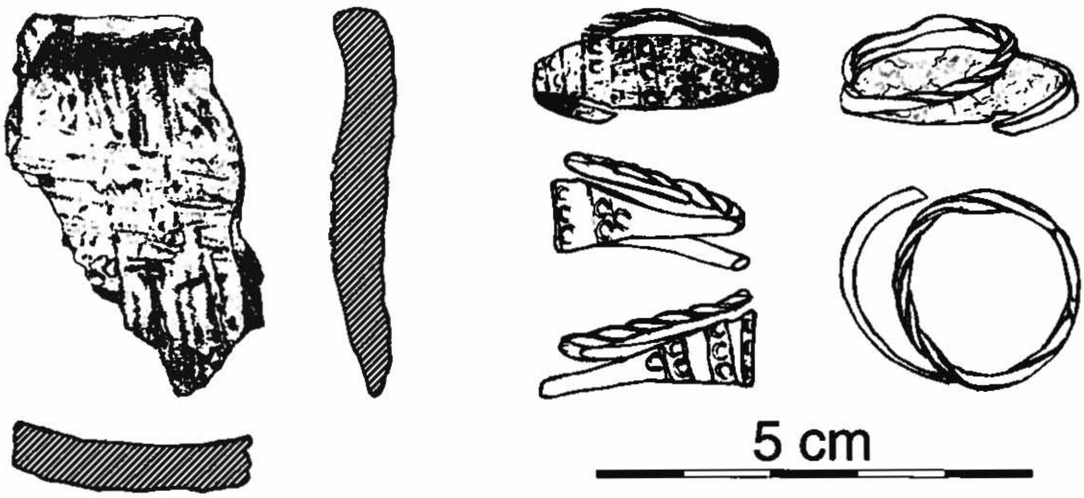

Fig. 9. A pot sherd (NM 24601:783) and a tin-plated bronze ring (NM 24601:22), both found at the area of the ancient field.

tending to a depth of 30 cm from the documentation level. It was of rectangular form with a kettle-shaped bottom and contained poorly burnt, porous and soft clay, including over 700 pieces of daub (1156 g). These pieces contained distinct impressions of branches and larger pieces of wood, particularly on their lower surfaces. A small amount of burnt bone, quartzes, and charcoal were found in the concentration, in addition to grains of corn recovered in the macrofossil analyses (see below).

The most distinct of the several plots of discoloured, dirty and sooty soil were large pits in the central parts of the ancient field. These features, which were almost devoid of finds, contained charcoal, streaks of soot and other traces of fire. In the southeast part of the field the ard marks overlay three long-shaped pits from which a few finds were recovered. In the upper part of the slope, above the ancient field, was a fireplace (II), which had been almost completely destroyed by ploughing at a later stage. It was not stratigraphically related to the ancient field, but radiocarbon dating may indicate a connection with the features beneath the traces of cultivation.

As already mentioned, the ancient field also revealed evidence of tillage in historically documented times, such as filled strip ditches and the effects of deep ploughing. Furthermore, the slope below the ancient field revealed a dark soil feature approximately two metres wide, which had probably been filled with household waste and debris in the 18th and 19th centuries. It may also be an old route of communication, as the map from 1641 suggests the presence of a path in this location.

THE FINDS

Only a relatively small amount of pre- or protohistoric material was recovered: fragments of bronze, iron and lithic artefacts, pot sherds, clay daub and iron slag. Part of this material came from the present plough layer in the upper part and margins of the ancient plough layer, which also contained recent finds from tillage in historically documented times. The only find of definite Iron Age date was recovered in the surface strata of the ancient field: a tin-plated bronze ring (NM 24601:22), which can be dated to the Viking Age and Crusade Period on the basis of known parallels (see Kivikoski 1973, 136, Abb. 1090, Tf. 122). As pointed out by conservator Leena Tomanterä (personal communication 1990), one of the rods of the object was apparently cut off deliberately, which suggests that the metal used secondarily. The object may therefore be discarded scrap metal, which would explain why it was found in the ancient field. Among the finds from beneath the ancient plough layer was an Epineolithic pot sherd with a scratched surface (NM 24601:783), which may be connected with previous occupation at the site (Fig. 9).

Material from historically documented times (burnt clay, brick, glass and other debris deposited along with dung) was found in the surface strata of the excavated area and was recovered to outline the history of tillage in this location. Historical or recent finds also extended down to the surface of the ancient plough layer and its margins as far as the ard-mark level. Recent material was not recovered in the lower part parts of the intact ancient field layer, nor in the layers beneath it.

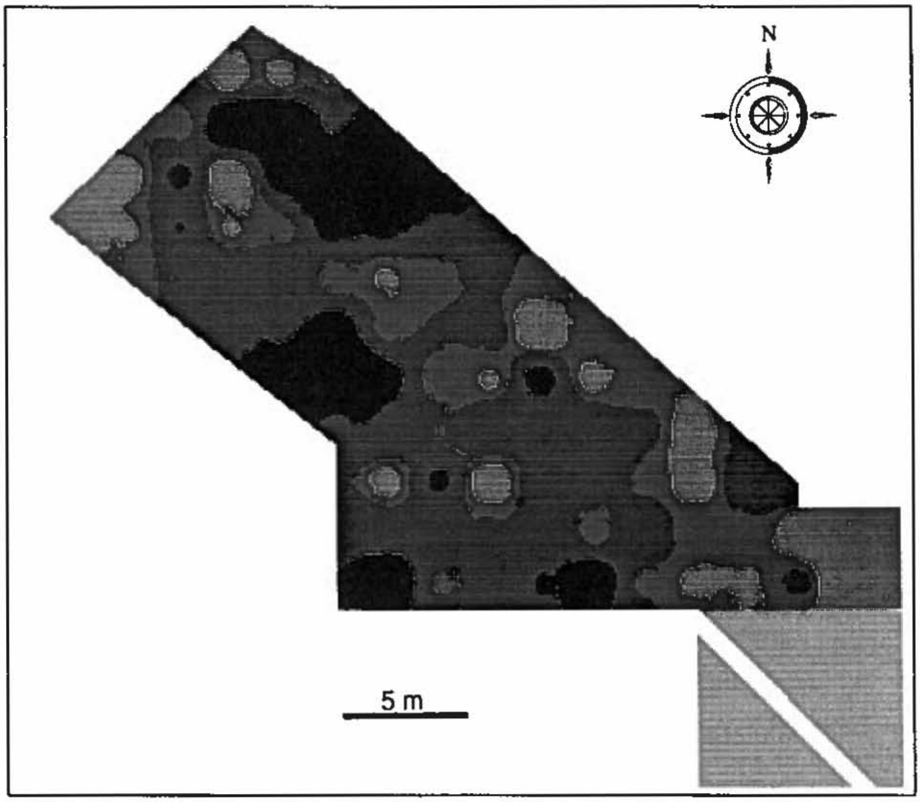

Fig. 10. Interpolated phosphate map of the ancient field. From light grey to black (1–5): 1. No samples. 2. First quartile 0–238 Pmg/kg. 3. Second quartile 239–296 Pmg/kg. 4. Third quartile 297–365 Pmg/kg. 5. Fourth quartile > 365 Pmg/kg.

SOIL ANALYSES

Soil samples for phosphate analyses were taken from the ard marks (Fig. 10). These were collected systematically from the soil beneath the documentation level, in most cases from the enriched layer. The results of the analyses vary between 101 and 549 Pmg/kg. Statistically (in quartiles), areas of significantly high phosphate content (>366 Pmg/kg) were observed in the margins of the ancient field and particularly at the gravel barrier on the north side (68% of all significant phosphate values). The areas of high anomalies contained very few indications of cultural layer, features of dirty soil, or finds. Phosphate content was lower than the average in the ancient field area. The proportion of organic material in the recent and ancient plough soil was investigated by measurements of humus content in two sample profiles. Humus content in the recent plough soil was of the average level (6%), while in the ancient plough layer it was considerably lower (2.4 and 3 %), indicating a relatively high mineral content in the soil.

^{14}C DATES

Nine radiocarbon samples, taken at different layers and contexts in the area of the Rapola field, were analysed at the Radiocarbon Laboratory of the University of Helsinki, Finland (Hel). In addition, three cereal grains were sent to be dated with the accelerator at the Svedberg Laboratory of the University of Uppsala, Sweden (Ua). Half-life 5568 was used and the results have been corrected to correspond to the 13C value of –25% compared with PDB. Results sorted by the sample ID are (Fig. 11):

Sample ID	CRA BP	
Hel-2680	2060±90	Fireplace I
Hel-2681	1110±80	Ard marks
Hel-2682	1680±110	Plot of dirty soil
Hel-2876	2130±100	Fireplace I
Hel-2877	1650±110	Plot of dirty soil
Hel-2878	1090±90	Ard marks
Hel-2879	2120±100	Plot of dirty soil and soot
Hel-2880	2090±110	Concentration of burnt clay
Hel-2881	2090±110	Fireplace II
Ua-3398	925±50	*Triticum cf. aestivum* grain, ard marks
Ua-3399	recent	Ignored
Ua-4149	1975±80	*Triticum compactum* grain, concentration of burnt clay

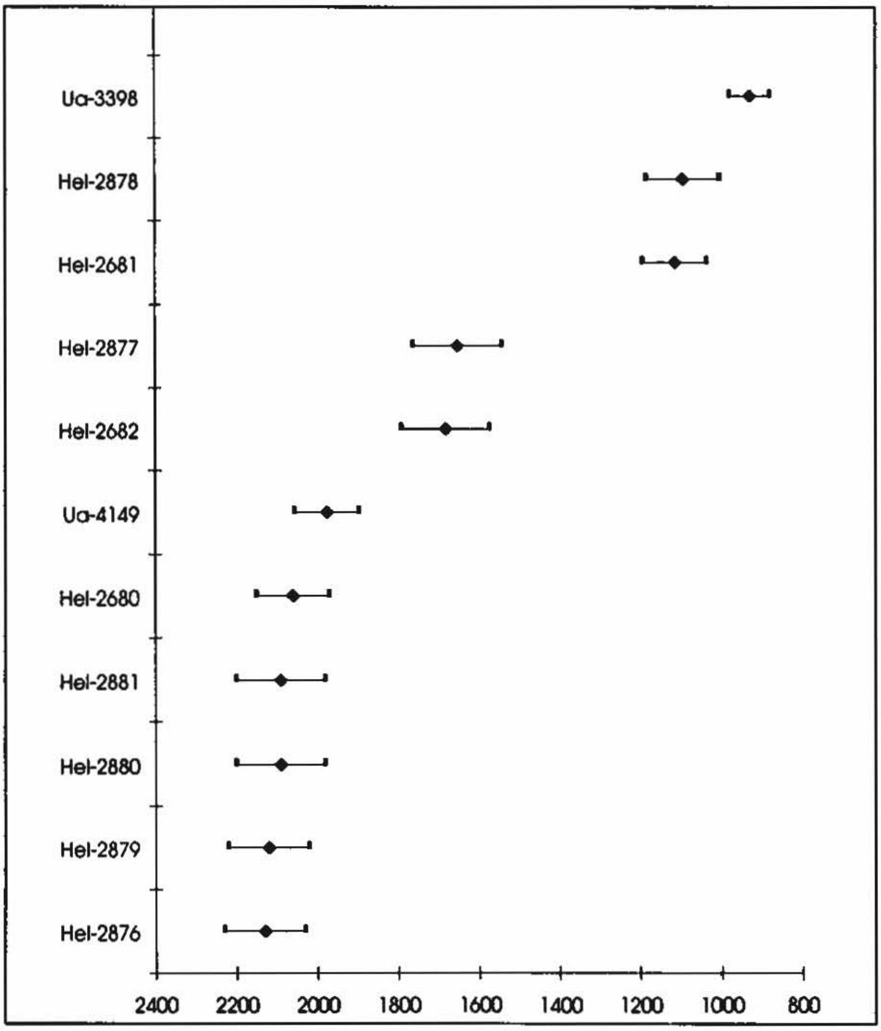

Fig. 11. Conventional ^{14}C dates (BP) of the field area.

All calculations were made using the Radiocarbon Calibration Program rev 3.0.2 of the Quaternary Isotope Lab of the University of Washington. Calibrations are based on the bidecadal tree-ring dataset 1 to 9440 cal BC combined with the inferred atmospheric spline of coral data to 20000 cal BC. Probabilities are calculated according to method B. (Stuiver - Reimer 1993; Stuiver - Pearson 1993)

These samples are significantly different at the 95% confidence level (T'= 382.02, χ^2= 18.3, $p<0.05$, statistic method by Ward - Wilson 1978). The dates, however, fall in three groups. The oldest group (I) consists of six dates. Two of these originate from the bottom of fireplace I, found partly at the ard-mark level and partly under it (Hel-2680, 2060±90; Hel-2876, 2130±100 BP). One sample was taken from the bottom of fireplace II, which had been badly damaged by modern agriculture. It was located outside the ancient plough layer and could not be stratigraphically compared with it (Hel-2881, 2090±110 BP). Two samples were taken from a plot of dirty soil slightly below the ard-mark level, containing both charcoal and soot (Hel-2879, 2120±100 BP) or burnt clay (Hel-2880, 2090±110 BP). The dated *Triticum compactum* grain was in the same context as the pieces of burnt clay (Ua-4149, 1975±80 BP).

Both samples of the middle group II were taken from a deep and large plot of dirty soil, which was located stratigraphically under the ard-mark layer. The pit contained several large pieces of charcoal and the samples were taken at points 10–20 cm beneath the ard marks (Hel-2682, 1680±110; Hel-2877 1650±110 BP).

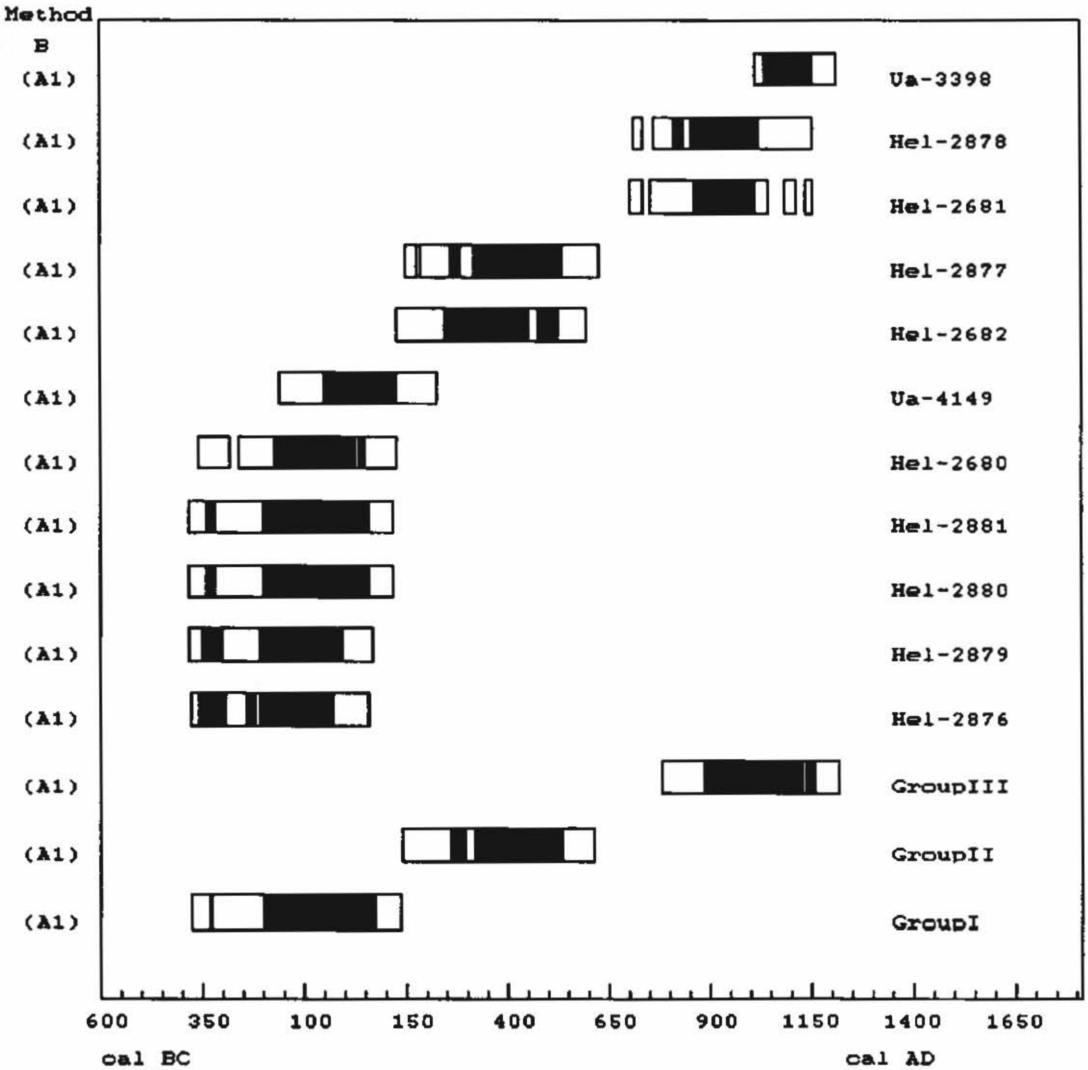

Fig. 12. Calibrated dates and sums of probabilities of groups I–III.

Two samples were collections of very small charcoal pieces collected precisely from the thin ard-mark layer (Hel-2681, 1110±80; Hel-2878, 1090±90 BP). To be sure that the charcoal really indicated the time of the ploughing, two cereal grains obtained by flotation procedure were sent for accelerator dating. The more interesting one was a *Triticum cf. aestivum* grain found in the samples taken from the ard-mark layer (Ua-3398, 925±50 BP). Flotated samples were taken also from layers above the traces, and a recent date was obtained (Ua-3399), which means that the corns from those layers can not be reliably connected with ancient agriculture and must be ignored.

Stratigraphically, group III represents the latest phase of the use of the area, and it is reflected only by agricultural remains. Features of both groups I and II are located beneath it but their stratigraphic relationship with each other cannot be solved because of the lack of convincing connections. Group I reflects habitation, but group II may equally result from any short-term activities.

For each of these groups, a similar method can be used to obtain a combined period of the activity they reflect. Pooled averages could be used in such cases, where all results may be considered as dates of one charcoal, and this average can then be calibrated. Only group II meets these requirements. To be sure that combined dates are comparable, we must use the same method for all groups. First, we have to test if they are statistically the same, and we find out that they are all statistically the same at the 95% confidence level.

	Test statistic T'	$\chi^2(.05)$
Group I	2.07	11.10
Group II	.04	3.84
Group III	5.02	5.99

Each calibrated date has limits within which the actual date falls at either the 95% or the 68% confidence level. These probabilities can be summed to obtain the corresponding date limits for each group (Fig. 12).

% area enclosed	calibrated age ranges	relative area under probability distribution
Group I		
68.3 (1σ)	332 - 328 BC	.01
	200 BC - 72 AD	.99
95.4 (2σ)	**378 BC - 137 AD**	**1.00**
Group II		
68.3 (1σ)	257 - 295 AD	.14
	319 - 534 AD	.86
95.4 (2σ)	**139 - 612 AD**	**1.00**
Group III		
68.3 (1σ)	885 - 1021 AD	.58
	1028 - 1066 AD	.13
	1073 - 1127 AD	.19
	1133 - 1159 AD	.09
95.4 (2σ)	**780 - 1217 AD**	**1.00**

Using the confidence level of 95% and having only a 5% probability of making mistakes we may say that the area was first inhabited in 378 cal BC - 137 cal AD. During this period, a house (or perhaps several) was built there, having fireplaces and clay constructions.

The next period of activity took place between 139 and 612 cal AD. In this case we may, however, use other methods because the two samples represent one single event. The pooled mean of the samples is 1665±78 BP, giving a calibrated date of 230 - 590 cal AD at 95% confidence level. The character of this activity cannot be specified.

Even though the dates of the *Triticum* grain and the collected charcoal pieces were statistically the same, we might consider the corn to represent later use of the same field. In this case, the two charcoal sample probabilities can be summed to 719 – 739, 766 – 1066, 1073 – 1128 and 1132 – 1159 cal AD (again at the 95% confidence level), and the date of the corn is 1020 – 1220 cal AD. However, the charcoal pieces are probably the remains of clearing the area by fire, and the age of the wood is much higher than the non-existent age of the corn. Unfortunately, the wood could have been 10 or just as well 100 years old, and for the same reason we cannot take this fact into account in case of the older periods. The last period of use, the ancient field, is therefore dated to 780 – 1217 cal AD.

ARCHAEOBOTANICAL RESULTS

Macrofossil plant remains have been studied previously in Finland only from one ancient field dated to the Iron Age, discovered at Kungsgård (Kastelholm), Åland in 1985 (Nunez - Lempiäinen, in press). About one hundred identified and unidentified remains of cereal grains were found there. The most common cereal in the material was *Hordeum vulgare*. In studies concerning the macrofossil plant material of ancient fields found in Central Europe, very few or no macroremains of cultivated plants have been found (e.g.. Zimmermann 1976, 1984).

The number of soil samples collected in 1988–89 from the different constructions and the ard marks of the ancient field was 139. Two samples were taken from the recent plough layer, 32 samples from the more or less disturbed ancient plough layer, 93 samples from the actual ard-mark layer and 12 samples from the other structures (app. I). The size of one flotated sample was about 1.5–2 dm^3. The sampling sites are shown in Fig. 5.

The soil samples were collected in the field by archaeologists. The macrofossil material was extracted from the soil samples by flotation in a saturated salt-water solution (Lempiäinen 1985). Seeds and other plant remains were extracted from the flotated material using a stereoscopic microscope (Wild M5) and stored in a 50 % alcohol solution. The nomenclature employed here follows that of Hämet-Ahti et al. (1986).

Appendix 1 lists the charred macrofossil finds from the layers of the ancient field. The number of charred remains of the total number of studied macrosubfossils was 271. Altogether, over 15 000 macrosubfossils from the ancient field were studied but only 1.63 % of them were carbonized.

The number of charred cereal grain finds was 57, i.e. 0.36% of the total number of studied remains and 22.01% of all the charred remains. Of these 73.7% (42) came from the layers of the ancient field dated more or less reliably to the Iron Age. 56 % of the grains were in such poor condition that it was not possible to identify them as species.

The most common finds were the charred grains of *Hordeum vulgare*, a total of 15 grains. Two charred remains of rachis of *Hordeum* were also found in the ancient plough layer. Two charred grains of *Secale cereale* and one of *Avena sativa* were found in the ancient plough layer, as well as the only charred grain of *Triticum cf. aestivum*, which was ^{14}C-dated to the Late Iron Age (Ua-3398; 1020 – 1220 cal AD, 2σ) . Two grains of *Triticum compactum* were identified from the concentration of burnt clay together with the grains of *Hordeum vulgare* (Fig. 13).

The dimensions of the measurable cereal grain finds were as follows (N=number, L=length, B=breadth, H=height):

Cereal	Context	L	B	H	L/B	L/H	B/H
Secale cereale	ancient plough layer	7.0	2.9	2.9	2.41	2.41	1.00
Hordeum vulgare	concentration of burnt clay	5.5	3.0	2.5	1.83	2.20	1.20
Hordeum vulgare	concentration of burnt clay	4.5	2.5	2.0	1.80	2.25	1.25
Mean of *Hordeum vulgare*		**5.0**	**2.75**	**2.25**	**1.82**	**2.23**	**1.23**
Triticum compactum	concentration of burnt clay	4.0	2.9	2.5	1.38	1.60	1.16
Triticum compactum	concentration of burnt clay	3.5	3.1	2.9	1.13	1.21	1.07
Mean of *Triticum compactum*		**3.8**	**3.0**	**2.7**	**1.26**	**1.41**	**1.12**

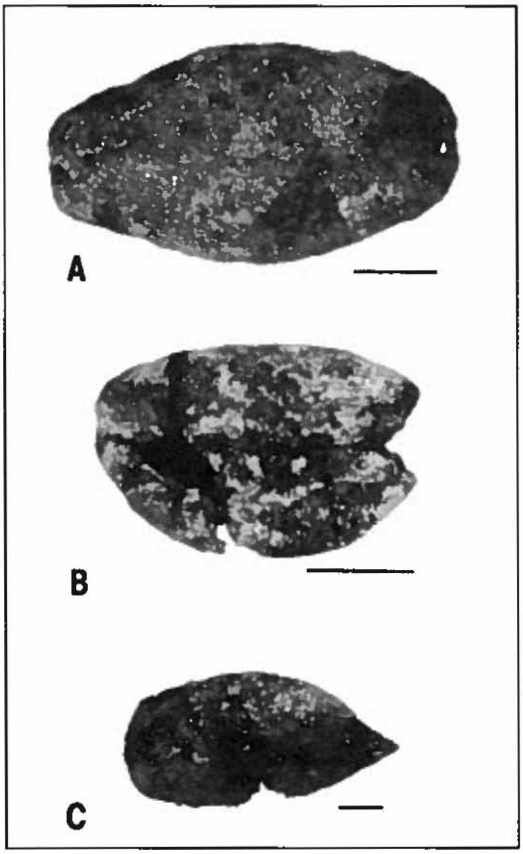

Fig. 13. Charred cereal grain finds from the ancient field. A. *Hordeum vulgare*, B. *Triticum compactum* and C. *Secale cereale*. Scale = 1 mm.

The grains of *Hordeum vulgare* were smaller than those from Varikkoniemi, Hämeenlinna (Lempiäinen 1992). The dimensions of the grains identified as *Triticum compactum* were very typical of the species (see also Kroll 1981, Matiskainen 1984). The mean length/breadth ratio was very low (mean 1.26), and it was clearly under the critical limit of 1.5.

Grains of *Triticum compactum* have been found at Virala, Janakkala, dated to the Late Iron Age (Lempiäinen - Schulz, unpubl.), at Karjaa, Domargård (dated to the Migration Period; Matiskainen 1984), Lieto, Pahka (the Late Iron Age; Seppä 1979) and at Turku, Old Market Place, dated to the Middle Ages (Lempiäinen, in press). According to many new macrofossil finds, it seems that *Triticum compactum* was cultivated over a very wide area in S Finland during the Iron Age. To a very limited extent this cereal was known to have been cultivated both in Central Europe and also in Finland as late as in the 19th century (Körber-Grohne 1987, Zohary - Hopf 1993, Soininen 1974).

The grains of *Triticum compactum* were found in the concentration of burnt clay, dated to the Pre-

Roman Iron Age (Hel-2880, 380 cal BC - 120 cal AD, 2σ). One of them was dated by the accelerator and it was slightly younger than the context, probably because of the non-existent own age of the grain (Ua-4149; 160 cal BC - 230 cal AD, 2σ). These are the oldest macrofossil grain finds of *Triticum compactum* in Finland, but about 1000 years younger than the grains of the oldest *Hordeum vulgare* (Vuorela - Lempiäinen 1988), which was, however, the most important cultivated cereal in S Finland in prehistoric times.

NATURAL VEGETATION

About 47 % of the identified macrofossil plant species were not found in the recent vegetation around the ancient field.

One charred seed of henbane (*Hyoscyamus niger*) was found in the border area of the ancient field (see also Lempiäinen 1990, 1991). This find came from the area of the ancient field where, along with those from the Iron Age, also the younger finds were dated. The henbane seed was too small to be dated by the ^{14}C method. Thus, it is rather uncertain, whether the henbane was a useful plant in Rapola as early as in the Iron Age. However, this find is important, because in the close vicinity there are no records of henbane plants. The nearest plants were found growing by the old Church of Sääksmäki some years ago (Kääntönen 1989).

Henbane is not an original plant in the flora of Finland. It was brought via central Europe from Southern Europe or Western Asia, perhaps by the Vikings and certainly in the Middle Ages by monks and travellers (Meusel et al. 1965, Hawkes 1972). As a medicinal plant, henbane has been used for several purposes in the Nordic Countries, especially to ease toothache and rheumatic pain. It has probably also played a role as a hallucinant in magic rituals. Henbane was first cultivated and later spread as a weed.

In the late 19th century, henbane was reported to be common in the north, but during the 20th century it has declined markedly. Its existence in many Northern European countries is nowadays considered to be threatened (Hultén 1971, Suominen 1979). The documented history of the henbane in Finland goes back to the 17th century. It was first mentioned in a plant catalogue by Elias Tillandz, a professor of the Academy of Turku, in 1673, and there was a drawing of the plant in the second edition of the catalogue, issued in 1683.

The Finnish name of *Hyoscyamus niger* is 'hullukaali', but there are over twenty popular names referring to the use of the characteristics of the plant. The word 'hullu' (mad) appears many times in the old names and clearly refers to the hallucinative character of henbane (Suhonen 1936). The macrofossil finds of henbane in Finland have been dated to the Iron or Middle Ages in Turku at Kuusisto (Lempiäinen 1991), The Old Market Place (Lempiäinen, in press) and Rettig (Lempiäinen 1993), and also at Varikkoniemi in Hämeenlinna, about 35 kilometers southeast of Rapola (Lempiäinen 1992). There are also finds dated to the 17th-18th centuries in Lappeenranta and Naantali (Lempiäinen 1991).

Juniperus communis grows even nowadays on the slopes of Rapola. The charred seed finds from the ancient field layers are, probably, of local origin. Juniper is, however, also a useful plant, that has been used earlier for many purposes (e.g. Lönnrot 1938, 1960). The plant was mentioned as a medicinal plant already in a herbal book of the Monastery of Naantali, written in the 15th century (Erkamo 1944, Masonen 1985).

Among the useful plants for Iron Age man there were also many berries, including *Fragaria vesca* and *Rubus idaeus*. According to Tillandz (1673, 1683) and Lönnrot (1838, 1860), many other plants of wild origin could be used for various purposes. Of the macrofossil finds in Rapola, the weeds used mainly as medicine were: *Spergula arvensis, Capsella bursa-pastoris, Trifolium repens, Stellaria media, Urtica dioica, Mentha arvensis, Polygonum aviculare* and *Viola sp.*

DISCUSSION

The stratigraphical observations obtained at Rapola have several parallels in the archaeological literature on Northern Europe. Ard marks have been described as traces of ancient tillage since the 1930s, and observations have been given dates from Neolithic times to the Iron Age (Lerche - Steensberg 1980, 60; Thrane 1991, 112; Nielsen 1993). They have been recorded and documented in numerous excavations, often in connection with dwelling sites and burials. Archaeological studies specifically concerned with traces of ancient cultivation have mainly been carried out in Denmark (e.g. Hatt 1949, Becker 1971; Nielsen 1970, 1987, 1993; Liversage et al. 1987) and in Sweden (see Green 1991 and cited literature). Similar research has recently been initiated in Estonia (Lôugas 1992; Lang 1994).

In Finland, traces of prehistoric cultivation – especially with reference to ard marks – did not come under detailed study until the 1980s in the Åland

Islands and the other western parts of the country (e.g. Katiskoski 1992; Liedgren 1991; Nunez - Lempiäinen in press). The ancient field at Rapola contains the first extensively studied remains of cultivation reliably dated to prehistoric times on the Finnish mainland. The present project can be regarded as a pioneering study both methodologically and in view of interpretation.

The topographical location of the field, stratigraphical observations and the related macrofossil studies all show that the ancient field at Rapola was the result of tillage, and activities available to economic and functional interpretations. There is no basis to regard it as a manifestation of ritual, as sometimes suggested in connection with ard marks discovered beneath barrows or burial cairns (e.g. Rowley-Conwy 1987; cf. Thrane 1991; Ramqvist 1992; Nielsen 1993). The precise area of the ancient field at Rapola cannot be defined, as there are no observations of distinct boundaries such as ditches or small embankments. The observed ard marks suggest the estimate that the longiform block-shaped field was roughly 500–600 m² in area. Some features in the sections surrounding the ard marks may be related to its boundaries or margins, such as the low embankment of gravel in the north part of the ancient field layer and ard-mark zone, a setting of stones in the southeast end, and a small ditch-like furrow in the southwest end. High soil phosphate values at the northern end may also indicate that the embankment was in fact a boundary, from which nutrients could not be obtained.

An important detail of the stratigraphy was the clearly concave shape of the bottom of the ancient field layer (i.e the documented level of ard marks). This has also been observed in other studies (Nielsen 1970, 152; Windelhed 1984, 96). It was probably caused by the continuous mechanical erosion of tillage and the processes of wear and accumulation of wind and water. The formation of the ard marks on the surface of the mineral soil can be attributed to a certain stage in working the field. Owing to erosion, continuous tillage thinned the humus layer so much that the ard share cut into the mineral soil. The marks would thus indicate the ultimate stages of cultivation, but not necessarily its oldest layer (Windelhed 1984, 96). The marks could also have come about, at least partly, in the early stages of tillage, whereby the later ard marks would be in the upper parts of the ancient plough layer (Nielsen 1970, 152).

In any case, the ard marks indicate the deepest ploughing at the site, which extended down to the mineral soil. Individual marks may derive from several ploughings, but are most probably from contemporaneous tillage. Ploughing into the mineral soil mixed sand into the field, which naturally decreased the humus and nutrient content of the cultivated soil. It is probable that the field soon had to be left fallow. There is no clear evidence of fertilization. On the other hand, the clearing of a field in the location of a Pre-Roman Iron Age site may not have been a pure coincidence. The occupation layer probably increased the nutrient content of the soil, as shown by the later flora at the site. High soil phosphate values at the edges of the field, the fragmentariness of the finds and the large proportion of charred material in the ancient plough layer may also indicate some kind of soil improvement, with, for example, household waste, although this need not have been systematic.

The ard marks also raise the question of technology and especially the type of implement used and the related methods of tillage. Ard marks in crisscross patterns are generally attributed to a simple ard (Fi. *aura*, Sw. *årder*), which, however, could not turn the soil in the manner of a plough. Accordingly, working the soil required ploughing in two, usually opposite, directions to break up the surface. This implement and the related method of tillage have survived in various parts of the world, including the Nordic countries, until the present day (Windelhed 1984, 96; Vuorela, T. 1975, 154). Some kind of ard was probably used at Rapola. There are no finds of prehistoric ards from Finland, but there is information on a few iron ard shares (Brady 1990). Interestingly enough, the only ard share from the Finnish mainland indicating Iron Age, and particularly Viking Age, cultivation has been discovered only 35 km southeast of Rapola (see Kivikoski 1973, Abb. 988). The remainder are from the Åland Islands.

In comparing the macrofossil results of the cereal grain finds with the pollen records (Tolonen 1979, 1978), it seems that *Hordeum* was the main cereal in Sääksmäki when agriculture first began there already about 840 BC, but a continuous curve comes as late as from 1200–1300 AD onwards. Among the macrofossils in the present material, grains from the Early and Late Iron Age were found. According to the first pollen and macrofossil records, the oldest evidence of agricultural activities in SW Finland has been dated to about 3200 BP (Vuorela - Lempiäinen 1988). The only grain of *Avena sativa* was found in the mixed soil material and it is possibly younger than the Iron Age. The first *Avena* pollen was found in the layers dated to about 1200 A.D. The earliest dates in southwestern Finland are between 930 and 1560 AD (Tolonen 1978). The first pollen records of *Secale cereale* in Sääksmäki are dated to about 270 AD (Tolonen 1978).

Most interesting are the records of *Triticum*.

Tolonen (1978) noted the first *Triticum* pollen in Sääksmäki from about 840 BC, as early as *Hordeum*, and a continuous curve about 300–800 AD According to the present macrofossil finds the first cultivated wheat type was *Triticum compactum*. There was also a find identified as *T.cf. aestivum* dated to the Late Iron Age. Several new finds of *Triticum compactum* in South Finland indicate, that this wheat type may have been more common in cultivation than has been assumed.

Comparing the present cereal material with that of Varikkoniemi, Hämeenlinna, it seems that the same cereal species were cultivated in both sites. The only exception was *Triticum compactum*, (dated to the transition between Pre-Roman and Roman Iron Age) that failed in Varikkoniemi, while the cultivated wheat there was *Triticum aestivum*, a modern hexaploid wheat type, a grain of which was also found at Rapola and dated to the Late Iron Age.

The majority (74.1 %) of the macrofossil finds from the ancient field were plant species of weeds and ruderals and very typical of cultivated fields and settlement soils with high nutrient contents. More remains of meadow plants were found in the levels of the ancient field than in the modern plough layer. Reasons why more weeds were growing along with the cereals, could be, e.g., that ancient fields were aerially smaller than modern fields, the time of use was shorter and the field-preparing methods were more primitive than later during the period of developed agriculture (e.g. Vuorela, T. 1975).

In view of the above discussion, the ancient field of Rapola represents the remains of prehistoric arable cultivation, with parallels in various parts of Northern Europe. According to the present interpretation, it was cleared in the topographically and micro-climatically optimum part of the slope at the site in sand and fine sand originally deposited in ancient shore formations. The field was cleared in the occupation layer of a Pre-Roman Iron Age site, in the 8th century in the Middle Iron Age at the earliest. It appears to have been in use for only a short time, perhaps only a few decades, including fallow periods. The period of use falls into the interval 780–1217 cal AD, as indicated by the available radiocarbon dates. Much later, by the 17th century at the latest, the site came under new cultivation following changes in tillage techniques and remained in use until recent times.

UNPUBLISHED SOURCES AND MAPS

Reports in topographic archives of the Department of Archaeology of the National Board of Antiquities, Helsinki.

Map of lots and fields 1641, Lars Schröder BB1A 23, Archives of the National Board of Survey, Helsinki.

Map of the quaternary deposits 1:20 000. 2132 02 SÄÄKSMÄKI. Geological Survey of Finland. Agricultural Research Centre of Finland. National Board of Survey. Helsinki 1988.

Lempiäinen, T. - Schulz, H.-P.: Cereal grain finds from a dwelling site in Virala, Janakkala (South Häme) dated to the Late Iron Age. Unpublished manuscript.

Masonen, J. 1985: Naantalin luostarin yrttikirja. Pro Gradu, unpublished manuscript. Department of History, University of Tampere.

Seppä, M. 1979: Liedon Pahkan Pahamäen subfossiiliset viljalajit kaivauksilta v. 1977. Pro Gradu, unpublished manuscript. Department of Botany, University of Oulu.

LITERATURE

Ailio, J. 1921: Rapolan muinaislinna Sääksmäellä. *Suomen Museo* 1920–1921.

Appelgren, Hj. 1891: Suomen muinaislinnat. Tutkimus vertailevan muinaistieteen alalta. *Suomen Muinaismuistoyhdistyksen Aikakauskirja* XII.

Becker, C. J. 1971: Früheisenzeitliche Dörfer bei Grøntoft, Westjutland. 3. Vorbericht: Die Ausgrabungen 1967–68. *Acta Archaeologica* XLII.

Brady, N.D.K. 1990: Early Ard Pieces in Finnish Museums. *Tools & Tillage* VI:3, 1990.

Erkamo, V. 1944: Vanhin Suomesta tunnettu lääkeopillinen kirjoitus. (Deutsches Referat: Die älteste aus Finnland bekannte medizinische Schrift). *Duodecim* 60.

Gren, L. 1991: Fossil åkermark. *Fornlämningar i Sverige* 1. Riksantikvarieämbetet. Stockholm.

Hatt, G. 1949: Oldtidsagre. Det Kongelige Danske Videnskabernes Selskab. *Arkæologisk-kunsthistoriske skrifter*, bind 11, nr. 1.

Hämet-Ahti, L. – Suominen, J. – Ulvinen, T. – Uotila, P. – Vuokko, S. 1986: *Retkeilykasvio*. Helsinki.

Hawkes, J.G. 1972: Hyoscyamus L. – In: Tutin, T.G. (ed.), *Flora Europaea* 3.

Hirviluoto, A.-L. 1987: Rapola. Erään maiseman historia. *Suomen Museo* 1986.

Hultén, E. 1971: *Atlas över växternas utbredning i Norden*. Stockholm.

Jutikkala, E. 1934: *Sääksmäen pitäjän historia*. Jyväskylä.

Katiskoski, K. 1992: The Kirkkomäki Cemetery at Kaarina. *Fennoscandia archaeologica* IX.

Kivikoski, E. 1973: *Die Eisenzeit Finnlands*. Bildwerk und Text. Neuausgabe. Helsinki.

Körber-Grohne, U. 1987: *Nutzpflanzen in Deutschland*. Stuttgart.

Kroll, H. 1981: Einige vorgeschichtliche Vorratsfunde von Kulturpflanzen aus Nord-Deutschland. *Offa* 37.

Lang, V. 1994: Fossil fields at Saha-Loo. *Eesti Teaduste Akadeemia Toimetised. Humanitaar- ja sotsiaalteadused* 43. Tallinn.

Lehtosalo-Hilander, P.-L. 1990: Rapolan aarteet ja Rupakallion ruostuneet raudat. *Kotiseutu* 1/1990.

Lempiäinen, T. 1985: Plant remains from the ancient lake Mätäjärvi in Turku, SW Finland. *Iskos* 5.

Lempiäinen, 1990: Rapolan muinaispellon kasviaarteet. *Sääksmäki* 1990.
Lempiäinen, T. 1991: Past occurrence of Hyoscyamus niger L. (Solanaceae) in Finland according to the macrofossil finds. *Annales Botanici Fennici* 28.
Lempiäinen, T. 1992: Pflanzliche Makroreste von der wikingerzeitlichen-frühmittelalterlichen Siedlung Varikkoniemi in Hämeenlinna, S Finland. *Suomen Museo* 1992.
Lempiäinen 1993: Makrofossiilitutkimuksesta ja sen tarpeellisuudesta Suomessa. Mitä on kasviarkeologia? *Varelia* 20/54.
Lempiäinen. T., in press: Macrofossil plant remains from Medieval Turku, SW Finland. *Offa*.
Lerche, G. – Steensberg, A. 1980: *Agricultural Tools and Field Shapes*. Twenty Five Years of Activity by the International Secretariat. International Secretariat for Research on the History of Agricultural Implements, Publication no. 3. National Museum of Denmark. Copenhagen.
Liedgren, L. 1991: Merovingertida bebyggelselämningar på Kalaschabrännan i Malax (With an English Summary). In Järnåldersbygd i Österbotten. En ekologisk-arkeologisk studie av bosättningskontinuitet och resursutnyttjande. Studier i Österbottens förhistoria nr. 2. *Acta Antiqua Ostrobotniensia*.
Liversage, D. – Munro, M.A.R. – Courty, M.-A. – Nürnberg, P. 1987: Studies of a Buried Early Iron Age Field. *Acta Archaeologica*, vol. 56 – 1985.
Lönnrot, E. 1838: *Suomalaisen talonpojan kotilääkäri*. Tampere.
Lönnrot, E. 1860: *Flora Fennica. Suomen Kasvisto*. Suomalaisen Kirjallisuuden Seura, Helsinki.
Lôugas, V. 1992: The Rebala Agricultural Protection Zone near Tallinn. In Estonia: Nature, Man and Cultural Heritage. *PACT* 37. Strasbourg.
Matiskainen, H. 1984: Getreidekörner aus der spätzeitlichen Siedlungskammer Domargård 1 in Karjaa, Südfinnland. *Fennoscandia archaeologica* I.
Meusel, H. Jäger, E. and Weinert, E. 1965: *Vergleichende Chorologie der zentraleuropäischen Flora*. Jena.
Nielsen, V. 1970: Iron Age Plough-Marks in Store Vildmose, North Jutland. *Tools & Tillage* I:3, 1970.
Nielsen, V. 1987: Ploughing in the Iron Age. Plough Marks in Store Vildmose, North Jutland. *Journal of Danish Archaeology* 5, 1986.
Nielsen. V. 1993: Jernalderens pløjning. Store Vildmose. Vendsyssel Historiske Museum.
Nunez, M. – Lempiäinen, T., in press: A late Iron Age farming complex from Kastelholms Kungsgård, Sund, Åland Islands. *PACT*.
Pälsi, S. 1921: *Vanhaa ja katoavaa*. Helsinki.
Ramqvist, P. H. 1992: Högom. The excavations 1949–1984. Högom Part I. *Archaeology and Environment* 13.
Rowley-Conwy, P. 1987: The interpretation of ard marks. *Antiquity* 61/232, July 1987.
Sarvas, A. 1976: Settlement of Sääksmäki in the Light of Archaeological Finds. *Finskt Museum* 1976.
Soininen, A.M. 1974: Vanha maataloutemme. Maatalous ja maatalousväestö Suomessa perinnäisen maatalouden loppukaudella 1720-luvulta 1870-luvulle. *Journal of the Scientific Agricultural Society of Finland* 46 (Suppl.).
Stuiver, M. – Reimer, P.J. 1993: Extended ^{14}C data base and revised CALIB 3.0 ^{14}C age calibration Program. *Radiocarbon* 35.
Stuiver, M. – Pearson, G.W. 1993: High-precision bidecadal calibration of the radiocarbon time scale, AD 1950-500 BC and 2500-600 BC. *Radiocarbon* 35.
Suhonen, P. 1936: Suomalaiset kasvinnimet (Deutsches Ref., Finnische Pflanzennamen). *Annales Botanici Soc. 'Vanamo'* 7.
Suominen, J. 1979: The grain immigrant flora of Finland. *Acta Botanica Fennica* 111.
Taavitsainen, J.-P. 1992: Cemeteries or refuse heaps? *Suomen Museo* 1991.
Taavitsainen, J.-P. 1990: Ancient Hillforts of Finland. Problems of Analysis, Chronology and Interpretation with Special Reference to the Hillfort of Kuhmoinen. *Suomen Muinaismuistoyhdistyksen Aikakauskirja* 94.
Thrane, H. 1991: Danish Plough-Marks from the Neolithic and Bronze Age. *Journal of Danish Archaeology* 8, 1989.
Tillandz, E. 1673: *Catalogus plantarum tam in excultis, quam in cultis locis prope Aboam superiore aestate nasci observatarum*. Aboae.
Tillandz, E. 1683: *Catalogus plantarum quae prope Aboam tam in excultis, quam in cultis locis hucuscue in ventae sunt*. Aboae.
Tolonen, M. 1979: On the Prehistoric Agriculture in Sääksmäki, S Finland. *Suomen Museo* 1976.
Tolonen, M. 1978: Palaeoecology of annually laminated sediments in Lake Ahvenainen, S. Finland. I. Pollen and charcoal analyses and their relation to human impact. *Annales Botanici Fennici* 15.
Tolonen, M. 1978 : The history of agriculture in Sääksmäki traced by pollen analysis. *Annales Botanici Fennici* 15/1.
Tolonen, K. – Siiriäinen, A. – Hirviluoto, A.-L. 1979: Iron Age cultivation in SW Finland. *Suomen Museo* 1976.
Voionmaa, J. 1953: Sääksmäen Rapolan rautakautinen kalmisto. *Suomen Museo* 1953.
Vuorela, T. 1975: *Suomalainen kansankulttuuri*. Porvoo-Helsinki-Juva.
Vuorela, I. – Lempiäinen, T. 1988: Archaeobotany of the cereal grain find in Finland. *Annales Botanici Fennici* 25.
Ward, G.K. – Wilson, S.R. 1978: Procedures for comparing and combining radiocarbon age determinations: A critique. *Archaeometry* 20/1.
Windelhed, B. 1984: "Celtic Fields" and Prehistoric Agrarian Landscapes. Settlement and Economy in Later Scandinavian Prehistory. *BAR International Series* 211.
Zimmermann, W.H. 1976: Die eisenzeitlichen Ackerfluren-Typ "Celtic field" von Flögeln-Haselhörn, Kr. Wesermüde. *Probleme der Küstenforschung* 11.
Zimmermann, W.H. 1984: Kulturverhältnisse, Nahrungsproduktion. *Archäologische und naturwissenschaftliche Untersuchungen an Siedlungen Küstengebiet* 1. *Ländliche Siedlungen*.
Zohary, D. – Hopf, M. 1993: *Domestication of Plants in the Old World*. 2nd ed., Oxford.

Appendix I:
Charred(*) macrofossil finds from the ancient field of Rapola. The finds are seeds/fruits, if not otherwise mentioned.

	Ancient field, macrofossils 1988				Ancient field, macrofossils 1989				
Layer	recent plough layer	mixed plough layer	ard mark layer	Sum	recent plough layer	mixed plough layer	ard mark layer	other structures	Sum
No. of Samples	1	6	67	74	1	26	26	12	65
Plant species									
CEREALS									
Avena sativa	-	-	1*	1	-	-	-	-	-
Hordeum vulgare, grain	-	1*	5*	6	-	1*	2*	9*	12
Hordeum vulgare, rachis	-	-	-	-	-	-	2*	-	2
Secale cereale	-	-	1*	1	-	-	-	-	-
Triticum cf. aestivum	-	-	1*	1	-	-	-	-	-
Triticum compactum	-	-	-	-	-	-	-	2	2
Cerealia	-	2*	19*	21	-	3*	4*	4*	11
WEEDS AND RUDERALS									
Bromus cf. secalinus	-	-	1*	1	-	-	-	-	-
Capsella bursa-pastoris	-	-	-	-	-	1*	2*	-	3
Chenopodium album	-	1*	16*	17	-	-	-	2*	2
C. suecicum	-	-	1*	1	-	-	-	-	-
Galium sp.	-	-	-	-	-	-	1*	-	1
Hyoscyamus niger	-	-	1*	1	-	-	-	-	-
Juncus sp.	-	-	-	-	-	-	2*	-	2
Polygonum aviculare	-	-	1*	1	-	2*	-	-	2
Raphanus raphanistrum	-	-	2*	2	-	-	-	-	-
Rumex acetosella	-	-	17*	17	-	-	1*	-	1
Spergula arvensis	-	-	1*	1	-	1*	-	-	1
Stellaria media	-	-	-	-	-	1*	-	-	1
Trifolium repens	-	1*	15*	16	-	1*	1*	-	2
Urtica dioica	-	-	1*	1	-	-	-	-	-

MEADOW PLANTS									
Agrostis sp.	-	-	-	-	-	-	1*	-	1
Festuca sp.	-	-	1*	1	-	-	-	-	-
Fragaria vesca	-	1*	3*	4	-	-	1*	-	1
Luzula pilosa	-	-	4*	4	-	-	-	-	-
Luzula sp.	-	-	-	-	-	-	4*	1*	5
Poa pratensis/trivialis	-	-	-	-	-	-	8*	-	8
Poaceae	-	-	1*	1	-	-	1*	4*	5
Rhinanthus sp.	-	-	-	-	-	-	2*	-	2
Stellaria graminea	-	-	3*	3	-	2*	-	-	2
Vicia cracca	-	-	1*	1	-	-	-	-	-
V. tetrasperma	-	-	-	-	-	-	-	1*	1
Viola sp.	-	-	3*	3	-	-	4*	-	4
NATURAL VEGETATION									
Rubus idaeus	-	-	1*	1	-	-	-	-	-
PLANTS OF SHORE, MARSH AND WATER									
Carex sp.	-	-	20*	20	-	1*	6*	1*	8
Mentha arvensis/aquatica	-	-	3*	3	-	-	2*	-	2
TREES AND SHRUBS									
Betula pendula/pubescens	-	-	1*	1	-	-	-	-	-
Juniperus communis, seed	-	4*	21*	25	-	3*	6*	-	9
Juniperus communis, needle	-	-	-	-	-	17*	1*	-	18
Picea abies, seed	-	-	3*	3	-	-	2*	-	2
Picea abies, needle	-	-	-	-	-	1*	1*	-	2
Pinus sylvestris	-	1*	-	1	-	-	-	-	-
Sum	-	11	148	159	-	34	54	24	112
OTHER REMAINS									
Bryophyta, leaf,stem	-	-	-	-	-	7	1	3	11
Fungi, sclerot.	21	123	1535	1679	5	512	497	198	1212
Charcoal	10	174	136	320	-	30	63	20	113
Insecta	-	-	-	-	-	13	9	16	38
Mollusca, shells	-	-	-	-	2	1	-	-	3
Total sum	31	308	1819	2158	7	597	624	261	1489